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A novel femtosecond time-resolved experiment has been set up to probe the photodissociation dynamics of negative ions and negative ion clusters. First results for the photodissociation of I, have been obtained recently.

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## FINAL TECHNICAL REPORT

**TITLE**: Study of Anion-Molecule Reaction Dynamics with Time-Dependent Photoelectron Spectroscopy

PRINCIPAL INVESTIGATOR: Daniel M. Neumark

**DATE**: December 16, 1994 - December 14, 1995

**GRANT NO:** F4960-95-1-0078

Abstract:

A novel femtosecond time-resolved experiment has been set up to probe the photodissociation dynamics of negative ions and negative ion clusters. First results for the photodissociation of  $I_2$ -have been obtained recently.

## Final Technical Report:

DURIP funds were used to purchase a Ti:sapphire femtosecond laser system (Model #CPA-1000 MPS) from Clark MRX Inc., at a cost of \$165,600. The Ti:sapphire femtosecond laser system is being used on a new experiment designed to study the photodissociation dynamics of negative ions and negative ion clusters on a femtosecond time scale. The novel feature of this experiment is that photoelectron spectroscopy is used to probe the dynamics of the dissociating anion in real-time. We have very recently obtained our first results on  $I_2$  photodissociation.

The principle of the experiment can be best understood by specifically considering its application to  $I_2$ :

$$I_2^- \xrightarrow[hv_1]{} I_2^{-*} \xrightarrow[\Delta t]{} I \cdot I^- \xrightarrow[hv_2]{} I_2 + e^-, I + I + e^-$$

This is a pump-probe experiment using two femtosecond laser pulses. The pump pulse  $(hv_1, 780 \text{ nm})$  excites mass-selected  $I_2^-$  from the ground  $X^2\Sigma_u^+$  state to the repulsive  ${}^2\Pi_{u(3/2)}$  state. The  $I_2^-$  begins to dissociate, and after a variable time delay  $\Delta t$ , the dissociating ions are photodetached with the probe pulse  $(hv_2, 260 \text{ nm})$ . We then measure the photoelectron spectrum, thereby mapping out the dissociating wave packet onto the well-known  $I_2$  potential energy surfaces.

At short times, one expects to see a transient associated with the dissociating  $I_2$ - molecule, and at longer times, the I- photoelectron spectrum should become more prominent as dissociation occurs. This is precisely what has been observed in our first measurements on  $I_2$ -. However, the time scale for dissociation appears to be several hundred fsec longer than predicted by our simulations that use the currently accepted potential energy curves for  $I_2$ -, indicating that these potentials may require significant modification. This issue will be addressed in further experiments and theoretical work.